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(54) Inflator

(57) The object is to provide an inflator wherein a gas can be expelled and supplied linearly in the axial direction of a bottle. In order to solve this problem, an inflator (1) includes a bottle (3), of which an opening (5) is connected to a diffuser (12) via a ring (6). A housing (17) is attached to the circumferential surface of the diffuser (12). An initiator (11) is retained in an outside part (17B) of the housing (17), and a barrel (21) is secured to an inside part (17A) of the housing (17). A piston (23) is disposed inside the barrel (21) in a slidable manner. When the initiator (11) generates an air blast, air flows inside the inside part (17A) of the housing (17) and a large diameter portion (21A) of the barrel (21) along a curved passage. Then, the piston (23) is pushed by the air blast and breaks a sealing plate (9) attached to the ring (6). Accordingly, a high pressure gas contained in the bottle (3) flows linearly inside the diffuser (12) and is then expelled out through a gas outlet (15).

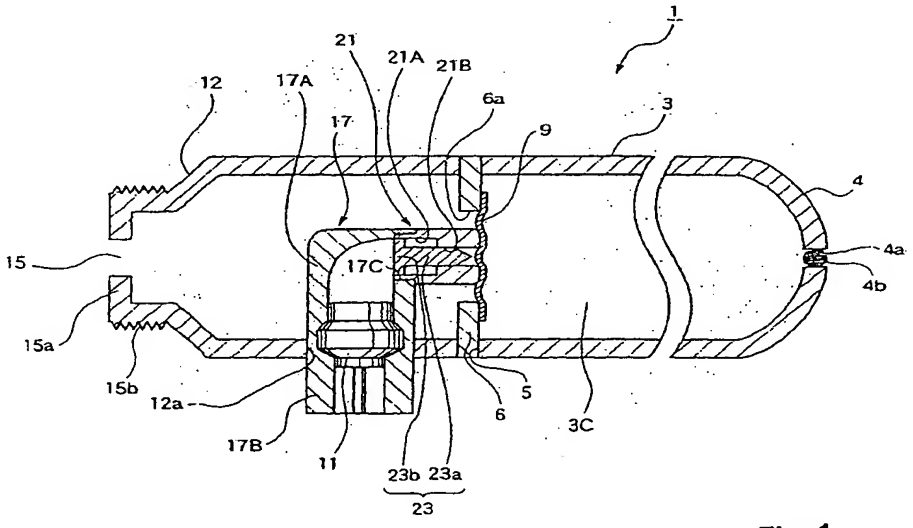

Fig. 1

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Description

[Technical Field of the Invention]

[0001] The present invention relates to an inflator which generates a gas for inflating air bags. More specifically, the present invention relates to an inflator having an advantage in that the gas can be expelled and supplied linearly in the axial direction of a bottle.

[Description of the Related Art]

[0002] Inflators are gas generators that generate a gas for inflating air bags for vehicles. Inflators can be broadly divided into two groups: inflators that expel a high pressure gas contained in a container and supply it to an air bag (hybrid type and stored gas type), and inflators that burn a gas generating agent (propellant) and generate a gas by utilizing a chemical reaction (combustion type).

[0003] An example of a stored gas type inflator is shown in Fig. 6.

[0004] Fig. 6 is a sectional side view which schematically shows an inflator disclosed in Japanese Unexamined Patent Application Publication No. 10-250525 as an example of a conventional stored gas type inflator.

[0005] With reference to the figure, an inflator 100 contains a bottle 101 which is filled with a high pressure gas. One end (the right end in the figure) 102 of the bottle 101 is closed and the other end (the left end in the figure) 103 of the bottle 101 is open. A sleeve 109 is connected to the open end 103 of the bottle 101 via an annular ring 106. The inner end of the ring 106, which forms an inside hole 106a, protrudes from the interior surfaces of the bottle 101 and the sleeve 109.

[0006] A burst disk 107 is attached to the ring 106 at the left side (the side facing the sleeve 109) thereof by welding, etc. The burst disk 107 is constructed of a steel plate having a thickness of approximately 0.3 mm. The burst disk 107 receives the filling pressure of the gas contained in the bottle 101 and swells toward the sleeve 109. In a normal state in which the inflator 100 is not activated, the bottle 101 is sealed by the burst disk 107.

[0007] A plurality of gas outlets 104, through which the high pressure gas is expelled when the inflator 100 is activated, are formed in the exterior surface of the sleeve 109. A housing 110 is attached to the sleeve 109 at the end (the left end in the figure) thereof. The housing 110 includes an initiator fixing member 110a, which is fit in the sleeve 109 at the end thereof, and a cylindrical portion 110b which protrudes from the initiator fixing member 110a. An initiator 112 is fixed inside the initiator fixing member 110a of the housing 110. A tip portion (at the right end) 112a of the initiator 112 is inserted beyond the initiator fixing member 110a into the cylindrical portion 110b. Terminals (at the left end) 112b of the initiator 112 are connected to a control unit via electric wires (not shown).

[0008] A piston 115, of which a tip 115a is sharply pointed, is disposed inside the cylindrical portion 110b of the housing 110. A hole 115b is formed in the piston 115 at the rear end thereof, and the tip portion 112a of the initiator 112 is disposed in the hole 115b. A tip 110c of the cylindrical portion 110b of the housing 110 is separated from the burst disk 107 by a predetermined distance as shown in the figure.

[0009] An air bag (not shown) is attached to the inflator 100 in such a manner that the air bag is communicated via the gas outlets 104. In a normal situation, the gas contained in the bottle 101 is sealed by the burst disk (sealing plate) 107. When the vehicle collides, a sensor (not shown) is activated and the initiator 112 generates an air blast, so that the piston 115 is pushed to the right in the figure. Then, the tip 115a of the piston 115 breaks the burst disk 107 at the midsection thereof, so that the entire body of the burst disk 107 is ruptured and opened widely. Then, the high pressure gas contained in the bottle 101 flows into the sleeve 109. The gas is then expelled out through the gas outlets 104 formed in the exterior surface of the sleeve 109 and supplied to the air bag.

[Problems to be Solved by the Invention]

[0010] In the above-described conventional inflator 100, the initiator 112, the piston 115, and the burst disk 107 are arranged such that the centers thereof are in line, and the piston 115 which is pushed by the air blast generated by the initiator 112 moves straight ahead and breaks the burst disk 107. However, in the above-described construction, the direction in which the gas flows into the sleeve 109 through the open end 103 of the bottle 101 (the horizontal direction in the figure) is approximately perpendicular to the direction in which the gas is expelled through the gas outlets 104 of the sleeve 109 into the air bag (the vertical direction in the figure). Accordingly, there is a problem in that the gas cannot flow linearly and smoothly, and an additional component is necessary for changing the flowing direction of the gas.

[0011] In order to solve this problem, in Japanese Unexamined Patent Application Publication No. 9-58394, a gas generator in which a gas can be expelled in the axial direction of a bottle, that is, the direction from the closed end (the end opposite to the end closer to an initiator) toward the other, is disclosed. However, in the gas generator of the above-described publication, there is a problem in that the size and the manufacturing cost thereof are increased since a large housing which contains the entire apparatus including the bottle is additionally provided.

[0012] In view of the above-described situation, an object of the present invention is to provide an inflator wherein a gas can be expelled and supplied linearly in the axial direction of a bottle without increasing the siz and the manufacturing cost th reof.

[Means for Solving the Problems]

[0013] According to the present invention, this object is achieved by an inflator as defined in claim 1 or claim 2. The dependent claim defines a preferred and advantageous embodiment of the present invention.

In order to solve the above-described problems, according to one aspect of the present invention, an inflator comprises a bottle which has an opening and which is filled with a high pressure gas; a sealing plate which seals the opening of the bottle; an initiator which generates an air blast which provides driving force for breaking the sealing plate; a piston which is accelerated by the air blast generated by the initiator and which breaks the sealing plate; and a curved passage which guides the air blast generated by the initiator to the piston.

[0014] According to the present invention, the air blast generated by the initiator moves non-linearly through the curved passage, and then pushes and accelerates the piston. Then, the accelerated piston breaks the sealing plate, and the high pressure gas contained in the bottle is expelled. Accordingly, it is not necessary to dispose the initiator in the axial direction of the bottle, and versatility of the design can be increased; for example, the high pressure gas can be expelled and supplied linearly in the axial direction of the bottle.

[0015] According to another aspect of the present invention, an inflator comprises a bottle which has an opening and which is filled with a high pressure gas; a sealing plate which seals the opening of the bottle; an initiator which generates an air blast which provides driving force for breaking the sealing plate; and a piston which is accelerated by the air blast generated by the initiator and which breaks the sealing plate. The bottle has a cylindrical shape, and the initiator is disposed in front of the opening of the bottle. In addition, a diffuser, which also has a cylindrical shape and which is provided with a gas outlet, is connected to the bottle in the extending direction thereof. In addition, the initiator is attached to the circumferential surface of the diffuser and the gas outlet is formed in the diffuser at the end opposite to the end closer to the bottle.

[0016] According to the present invention, the initiator is disposed in front of the opening of the bottle and is attached to the circumferential surface of the diffuser. Thus, the initiator is not disposed in the direction in which the high pressure gas is expelled. Accordingly, the high pressure gas can be expelled and supplied linearly in the axial direction of the bottle. The high pressure gas which comes out from inside the bottle flows linearly through the diffuser and is expelled out through the gas outlet formed in the diffuser at the end opposite to the end closer to the bottle.

[0017] The inflator of the present invention may further comprise a barr l having an inside hole which guides the piston, and the nd surface of the barrel which is closer to the bottle may be in contact with the sealing plate.

In such a case, the barrel receives a considerable percentage of the filling pressure of the gas contained in the bottle. Thus, even a sealing plate having a relatively small thickness can sustain a high pressure. After the sealing plate breaks, the gas flows through the space between the interior surface of the diffuser and the exterior surface of the barrel, and is then expelled through the gas outlet.

[Brief Description of the Drawings]

[0018]

Fig. 1 is a sectional view of an inflator according to an embodiment of the present invention in a state before the inflator is activated.

Fig. 2 is a sectional view of the inflator in a state immediately after activation of the inflator starts.

Fig. 3 is a sectional view of the inflator in a state in which the inflator is being activated.

Fig. 4 is an exploded sectional view of the inflator.

Fig. 5 is a schematic drawing which shows modifications of a piston and a barrel of the inflator according to the present invention, where (A) and (B) are perspective views showing modifications of the piston, (C) and (D) are perspective views showing modifications of the barrel, (E) is a sectional view of (D) before activation, and (F) is a sectional view of (D) after activation.

Fig. 6 is a sectional side view which schematically shows an inflator disclosed in Japanese Unexamined Patent Application Publication No. 10-250525 as an example of a conventional stored gas type inflator.

[Description of Preferred Embodiments]

[0019] The present invention will be further illustrated in conjunction with the drawings.

Fig. 1 is a sectional view of an inflator according to an embodiment of the present invention in a state before the inflator is activated.

Fig. 2 is a sectional view of the inflator in a state immediately after activation of the inflator starts.

Fig. 3 is a sectional view of the inflator in a state in which the inflator is being activated.

Fig. 4 is an exploded sectional view of the inflator.

In the following descriptions, the "horizontal direction" and "vertical direction" correspond to the horizontal and vertical directions as seen in the figures.

[0020] With reference to the figures, an inflator 1 includes a bottle 3 which is formed of steel and which has a cylindrical shape. The bottle 3 has an end portion 4 having a hemispherical shape at the right end thereof, and an opening 5 at the l ft end thereof. A hole 4a is formed in the end portion 4 of the bottle 3, and a gas such as an inert gas, etc., is injected into an interior 3C

of the bottle 3 through the hole 4a at a high pressure. After the interior 3C of the bottle is filled with the gas, the hole 4a is blocked by a steel ball 4b so that the gas is sealed.

[0021] A diffuser 12 is connected to the opening 5 of the bottle 3 via a ring 6 which is constructed of a steel plate having an annular shape. The bottle 3, the ring 6, and the diffuser 12 all have the same outside diameter and are joined together by welding, etc. As shown in Figs. 1 to 3, the inner end of the ring 6, which forms an inside hole 6a, protrudes from the interior surfaces of the bottle 3 and the diffuser 12. A sealing plate (burst disk) 9, which is constructed of a disk-shaped steel plate, is attached to the ring 6 at the right side (the side facing the bottle 3) thereof by welding, etc. The inside hole 6a of the ring 6 (the opening 5 of the bottle 3) is sealed by the sealing plate 9. The thickness of the sealing plate 9 is, for example, 0.2 to 0.4 mm.

[0022] The diffuser 12 is a cylindrical member formed of steel, etc., and the right end portion (a portion connected to the ring 6) thereof has the shape of a straight cylinder. The diffuser 12 is tapered toward the left end thereof, and a gas outlet 15 is formed at the left side of the tapered portion. When the inflator 1 is activated, the high pressure gas contained in the bottle 3 is expelled through the gas outlet 15. A flange 15a is formed at the end of the gas outlet 15, and an external thread 15b is formed in the exterior surface thereof. The external tread 15b is engaged with a fixing flange 25 (see Fig. 4), which is provided for securing an open end of an air bag (not shown).

[0023] A through hole 12a is formed in the circumferential surface (the bottom surface as seen in the figures) of the diffuser 12, and a housing 17 is inserted through the through hole 12a. As is comprehensively shown in Fig. 4, the housing 17 includes an inside part 17A, which is disposed inside the diffuser 12, and an outside part 17B, which is disposed outside the diffuser 12. The inside and outside parts 17A and 17B are joined together by welding, caulking, etc. The upper surface of the housing 17 (the upper surface of the inside part 17A) is closed, and the bottom surface thereof (the bottom surface of the outside part 17B) is open.

[0024] An initiator 11 is retained in the outside part 17B of the housing 17, and an end portion of the initiator 11 is inserted in the inside part 17A. The initiator 11 is connected to a control unit (not shown) via electric wires. The initiator 11 generates an air blast which provides driving force for breaking the sealing plate 9 when the inflator 1 is activated.

[0025] As is comprehensively shown in Fig. 4, a through hole 17C is formed in the right surface of the inside part 17A of the housing 17 at the right side thereof. An internal thread is formed in the inner periphery of the through hole 17C, and a barrel 21 having a cylindrical shape is screwed into the through hole 17C. As shown in Figs. 1 to 3, in the state in which the housing 17 and the barrel 21 are joined, they are constructed like a reducing elbow having a curved passage ther in. On end of the barrel 21 (the right end in Fig. 1) is in contact with the side surface of the sealing plate 9 at the left side thereof. Accordingly, the barrel 21 receives a considerable percentage of the filling pressure applied to the sealing plate 9 by the gas contained in the bottle 3. Thus, the sealing plate 9 having a relatively small thickness such as 0.2 to 0.4 mm can sustain a high pressure.

[0026] As shown in Figs. 1 to 3, the barrel 21 has an inside hole which includes a large diameter portion 21A at the side closer to the housing 17 and a small diameter portion 21B at the side closet to the sealing plate 9. A piston 23, which includes a shaft portion 23a and a flange portion 23b, is disposed inside the inside hole of the barrel 21 in a slidable manner. The outside diameter of the shaft portion 23a is slightly smaller than the inside diameter of the small diameter portion 21B, and the outside diameter of the flange portion 23b is slightly smaller than the inside diameter of the large diameter portion 21A. The tip of the piston 23 is sharply pointed.

[0027] Next, the operation of the inflator 1 having the above-described construction will be described below.

As shown in Fig. 1, in a normal state in which the inflator 1 is not activated, the interior 3C of the bottle 3 is filled with the gas and is sealed by the sealing plate 9. The sealing plate 9 serves to prevent the gas from leaking through the opening 5 of the bottle 3. The piston 23 is retained in the barrel 21 at a predetermined position shown in Fig. 1. In this state, the right end of the barrel 21 is in contact with the sealing plate 9, and the tip of the piston 23 is separated from the sealing plate 9.

[0028] When a vehicle containing the inflator 1, which is in a state shown in Fig. 1, receives the impact, the inflator 1 is activated and the high pressure gas contained in the bottle 3 is supplied to the air bag (not shown). In such an emergency situation, the control unit (not shown) outputs an electric ignition signal, and the initiator 11 generates an air blast based on the ignition signal. Accordingly, as shown in Fig. 2, air flows inside the inside part 17A of the housing 17 and the larg diameter portion 21A of the barrel 21 along the curved passage, so that the piston 23 is pushed to the right in the figure.

[0029] Then, as shown in Fig. 3, the tip of the piston 23, which is pushed by the air blast, breaks the sealing plate 9. Accordingly, the entire region of the sealing plate 9 ruptures and the high pressure gas contained in the bottle 3 starts flowing out through between the exterior surface of the barrel 21 and the inside hole 6a of the ring 6 into the diffuser 12. The gas is then expelled and supplied to the air bag (not shown) through the gas outlet 15. Accordingly, the air bag is inflated. As described above, during the time in which the gas comes out from the bottle 3, flows inside the diffuser 12, and is supplied into the air bag, the gas flows linearly. The piston 23 pushed by the air blast generated by the initiator 11 is stopped since the flange portion 23b ncounters the st p portion between the large diameter portion 21A and

the small diameter portion 21B inside the barrel 21.

[0030] Next, modifications of the piston and the barrel will be described below.

Fig. 5 is a schematic drawing which shows modifications of the piston and the barrel. In Fig. 5, (A) and (B) are perspective views showing modifications of the piston of the inflator according to the present invention, and (C) and (D) are perspective views showing modifications of the barrel of the inflator according to the present invention. In addition, (E) is a sectional view of (D) before activation, and (F) is a sectional view of (D) after activation.

A piston 30 shown in Fig. 5(A) includes a shaft portion 30a and a flange portion 30b. The tip of the shaft portion 30a is sharply pointed. A plurality of grooves 30c is formed in the peripheral surface of the flange portion 30b along the thickness direction thereof. In the piston 30, when the initiator is activated, air flows through the grooves 30c toward the tip of the piston 30. Accordingly, the internal pressure of the barrel can be reduced, so that the pressure resistance of the barrel can be set to a relatively low value.

[0031] A piston 35 shown in Fig. 5(B) includes a shaft portion 35a and a flange portion 35b. A hollow portion 35c is formed along the shaft center (that is, the center of the shaft portion 35a and the flange portion 35b) of the piston 35. In the piston 35, when the initiator is activated, air flows through the hollow portion 35c toward the sealing plate, so that the midsection of the sealing plate ruptures such that a circular hole is formed therein. Accordingly, the sealing plate always breaks in a similar manner.

[0032] A barrel 40 shown in Fig. 5(C) includes a main body 41 having a cylindrical shape, and a flange 42 is formed at the end of the main body 41 which is closer to the bottle (that is, the end closer to the sealing plate, or the right end in the figure). A plurality of holes (orifices) 42a are formed in the flange 42. In the barrel 40, the flange 42 having a large area is in contact with the sealing plate. Accordingly, the sealing plate can be more effectively restrained. After the sealing plate is ruptured by the piston which slides inside the barrel 40, the gas contained inside the bottle flows through the holes 42a.

[0033] A barrel 45 shown in Fig. 5(D), (E), and (F) includes a main body 46 having a cylindrical shape, and the diameter of an end portion 47 of the main body 46 at the end closer to the bottle (that is, the end closer to the sealing plate, or the right end in the figure) is gradually reduced. In addition, the diameter of an end portion 48 of the main body 46 at the end farther from the bottle (that is, the end closer to the housing, or the left end in the figure) is gradually increased. In the barrel 45, the tip of a piston 50 is inside the barrel 45 in the state before activation, and the tip of the piston 50 protrudes out from th opening formed in the end portion 47 of the barrel 45 in the state after activation. The piston 50 slides inside the main body 46 and is th n stopped by becoming engaged by an inside hole of the end portion 47 which becomes narrow r toward the end. Accordingly, the above-described flange portion, which is formed at the rear end of the piston, can be omitted and the shape of the piston can be made simpler.

[0034] In addition, the above-described inflator allows, for example, the following modifications.

(1) A construction in which the initiator is omitted and the piston is manually moved in order to break the sealing plate. This construction is effective in a case in which the inflator is applied to a device which is not an air bag apparatus for vehicles (for example, extinguisher, life jacket, etc.).
(2) A construction in which the piston is disposed inside the bottle.
(3) A construction in which the housing is attached to the side surface of the bottle, and the internal pressure of the bottle is increased by using solid, liquid, fuel, etc., so as to break the sealing plate. In this case, the piston can be omitted.

[Advantages]

[0035] As is apparent from the foregoing explanations, according to the present invention, an inflator in which a gas can be expelled and supplied linearly in the axial direction a bottle without increasing the siz and the manufacturing cost thereof can be provided.

Claims

1. An inflator comprising:

   a bottle (3) which has an opening (5) and which is filled with a high pressure gas;
   a sealing plate (9) which seals the opening (5) of the bottle (3);
   an initiator (11) which generates an air blast which provides driving force for breaking the sealing plate (9);
   a piston (23; 30; 35; 50) which is accelerated by the air blast generated by the initiator (11) and which breaks the sealing plate (9); and
   a curved passage (17, 21) which guides the air blast generated by the initiator (11) to the piston (23; 30; 35; 50).

2. An inflator comprising:

   a bottle (3) which has an opening (5) and which is filled with a high pressure gas;
   a sealing plate (9) which seals the opening (5) of the bottle (3);
   an initiator (11) which generates an air blast which provides driving force for breaking the sealing plate (9); and
   a piston (23; 30; 35; 50) which is acc lerated

by the air blast generated by the initiator (11) and which breaks the sealing plate (9),

wherein the bottle (3) has a cylindrical shape,

wherein the initiator (11) is disposed in front of the opening (5) of the bottle (3) and a diffuser (12), which also has a cylindrical shape and which is provided with a gas outlet (15), is connected to the bottle (3) in the extending direction thereof, and

wherein the initiator (11) is attached to the circumferential surface of the diffuser (12) and the gas outlet (15) is formed in the diffuser (12) at the end opposite to the end closer to the bottle (3).

3. An inflator according to one of Claim 1 and Claim 2, further comprising a barrel (21; 40; 45) having an inside hole which guides the piston (23; 30; 35; 50),

wherein the end surface of the barrel (21; 40; 45) which is closer to the bottle (3) is in contact with the sealing plate (9).

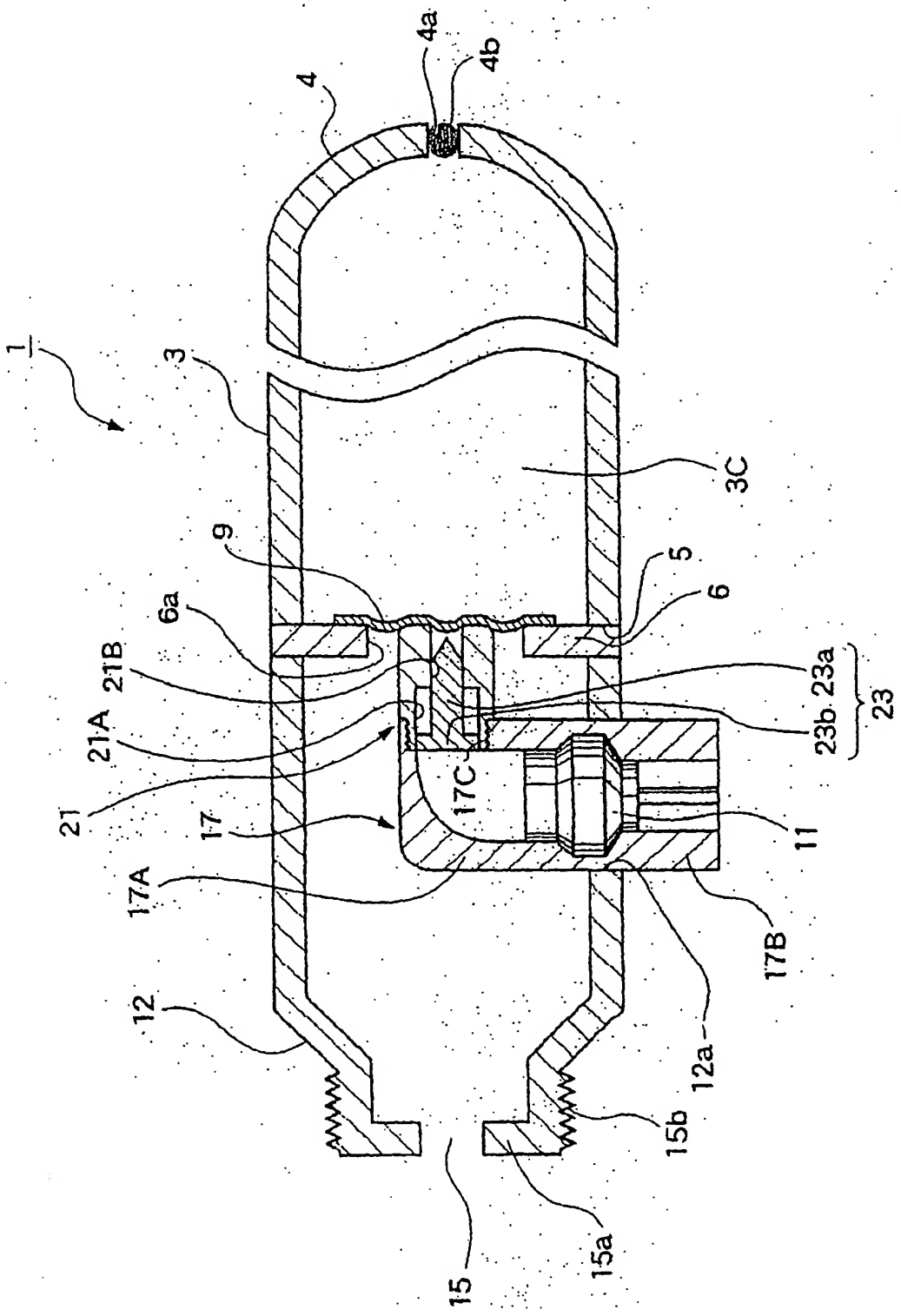
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Fig. 1

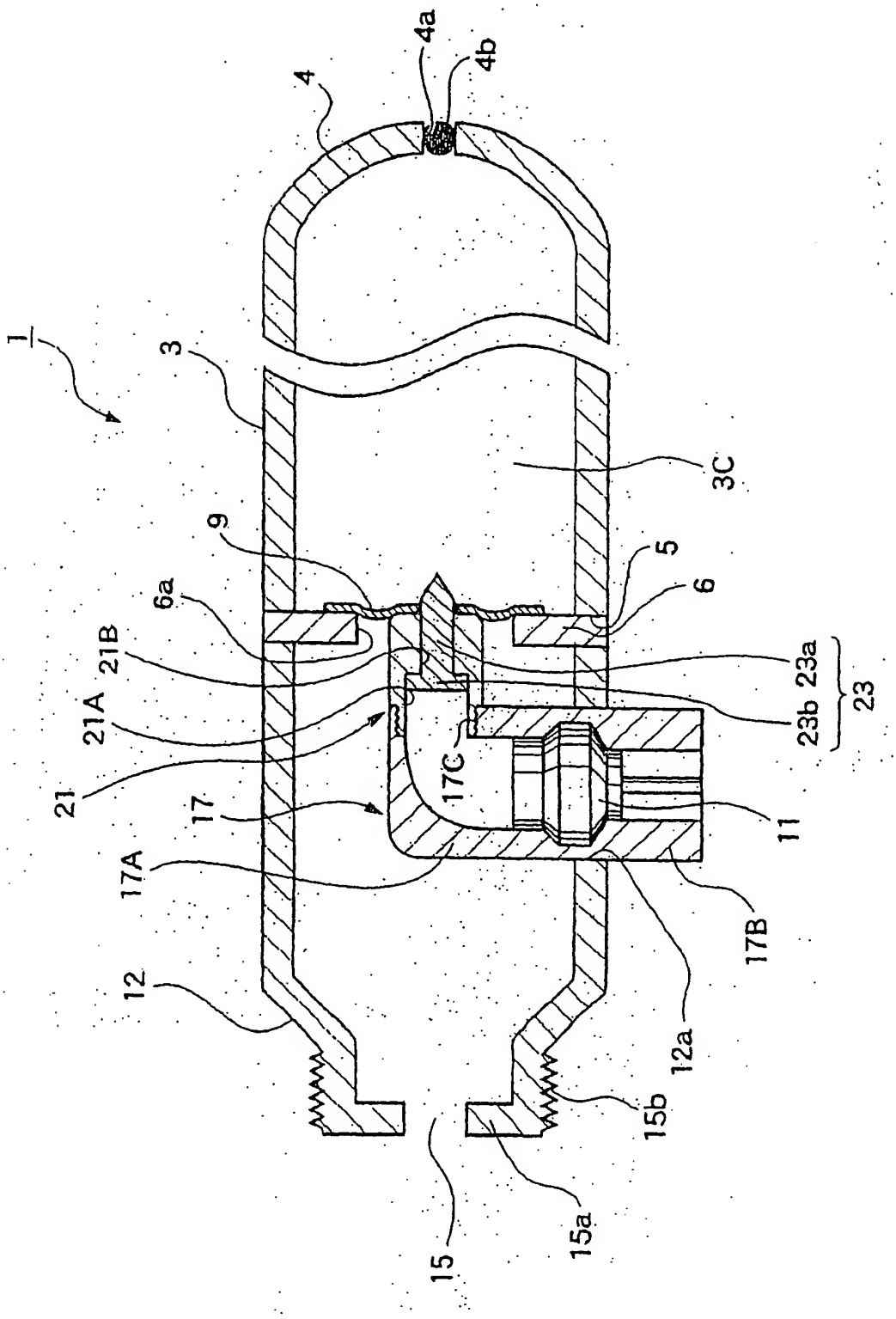
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Fig. 2

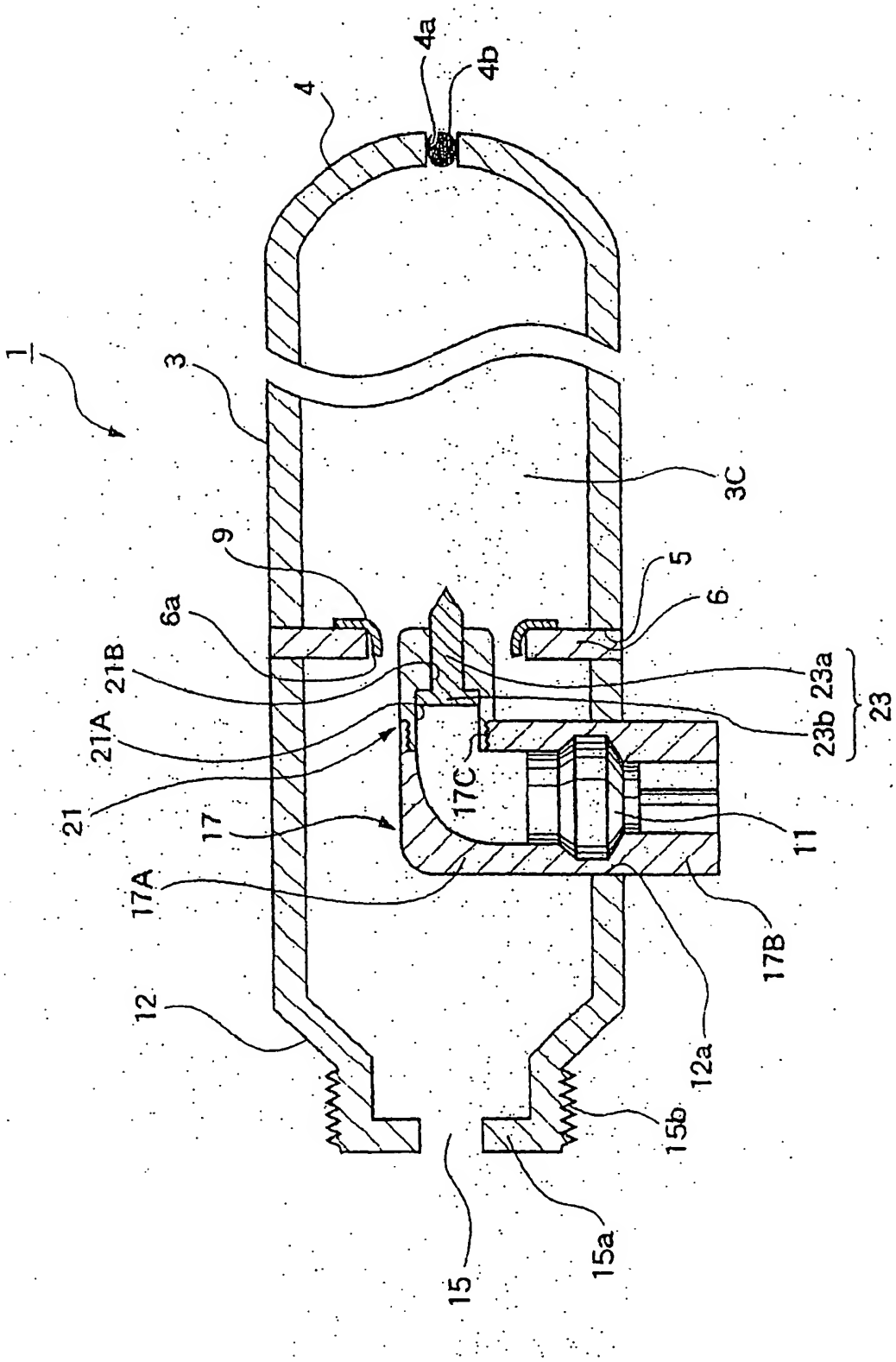
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Fig. 3

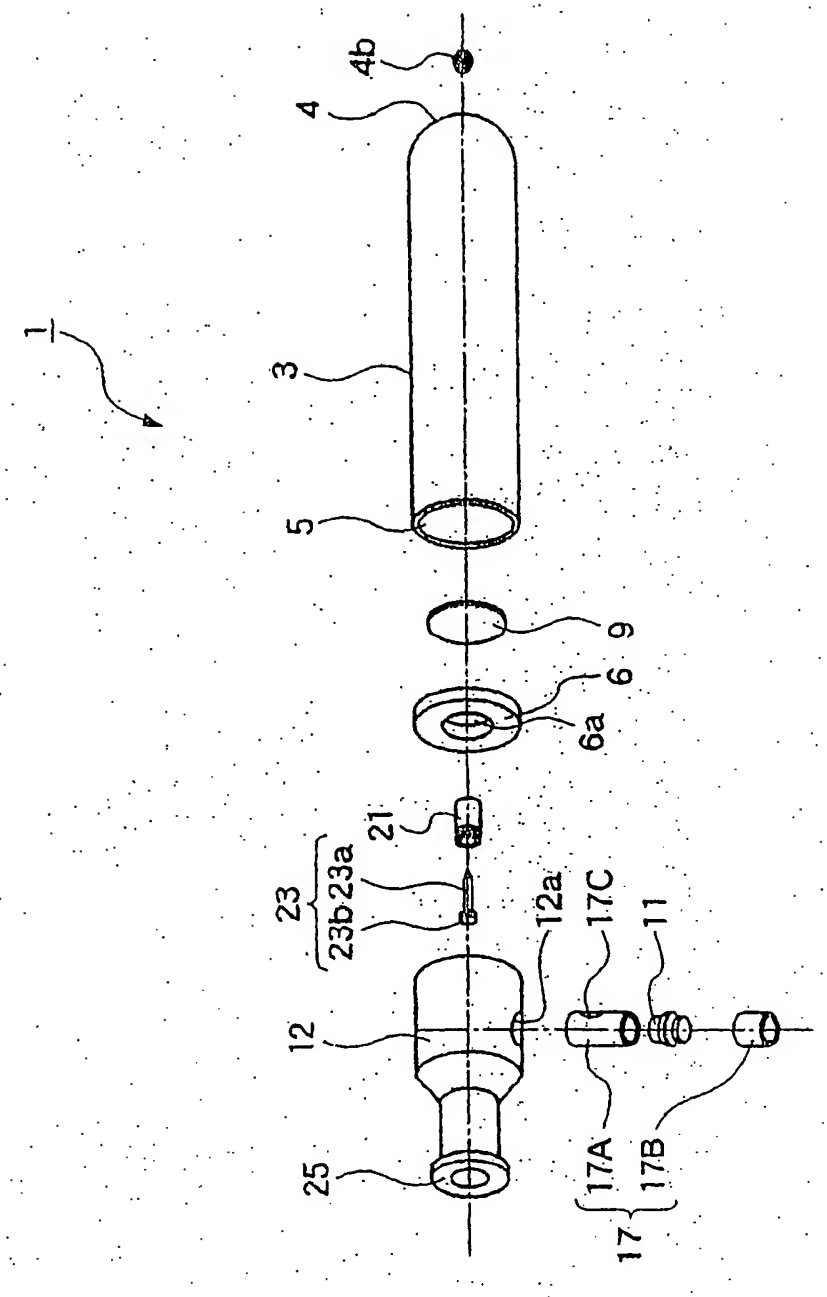

Fig. 4

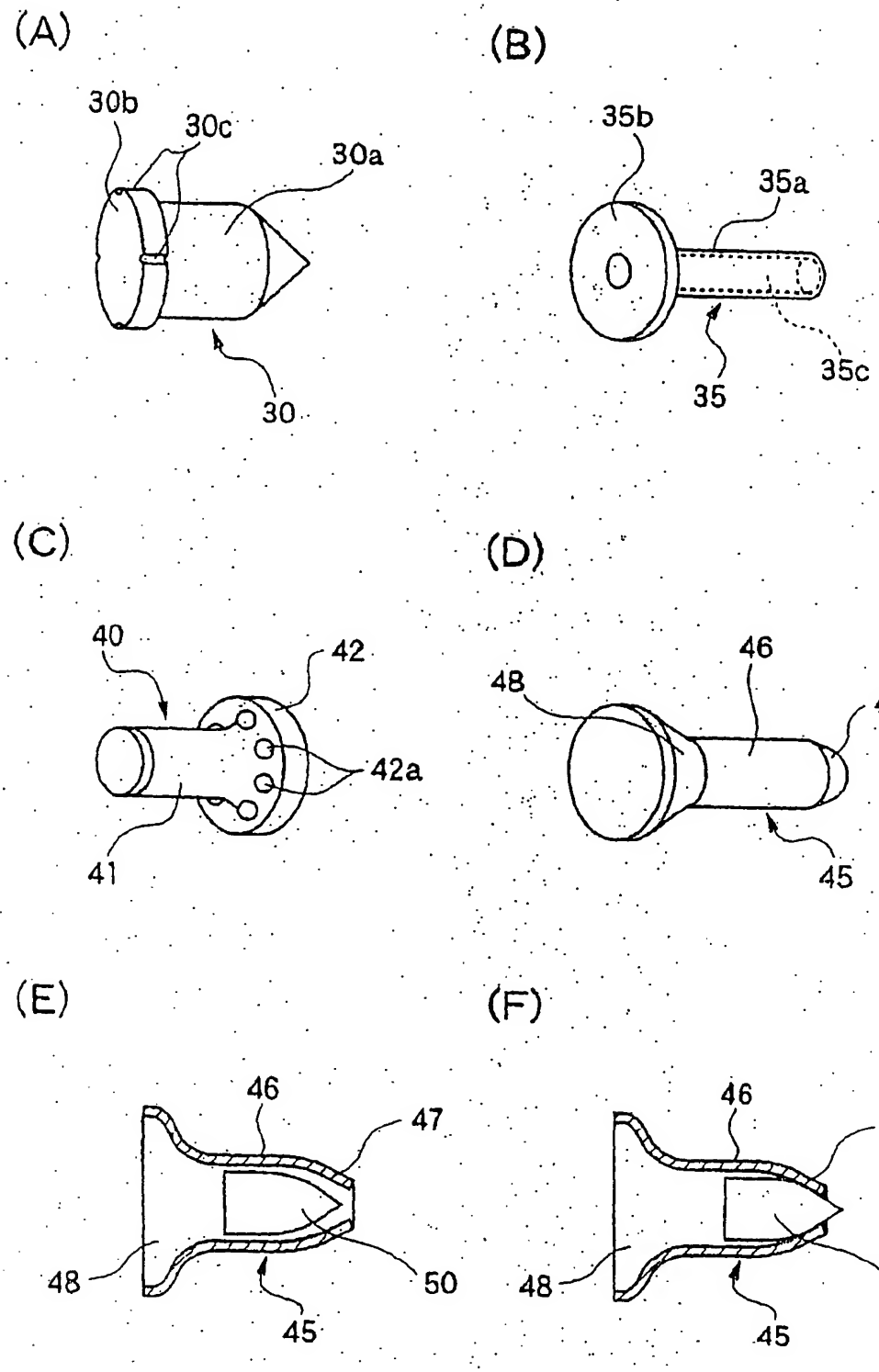
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Fig. 5

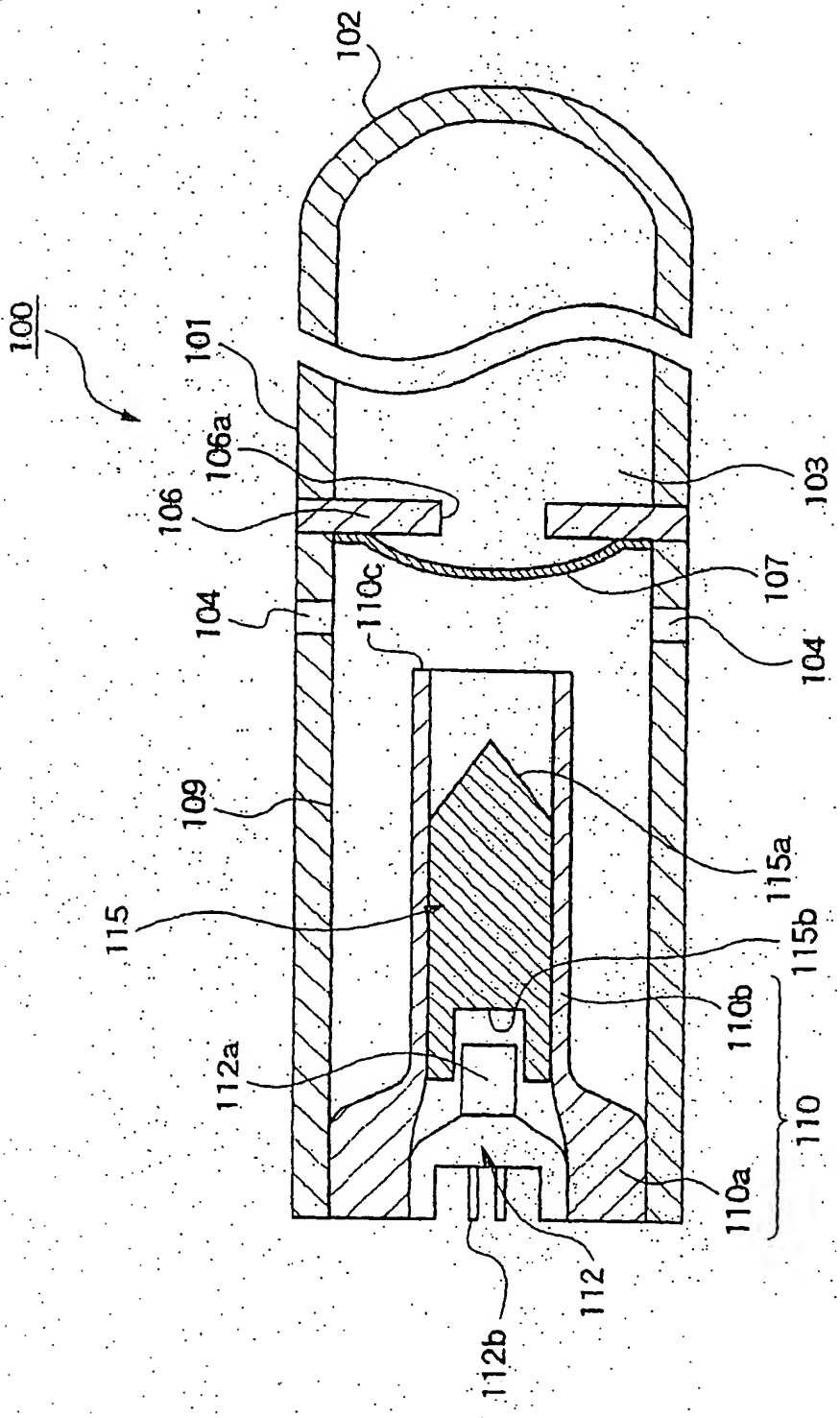
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Fig. 6